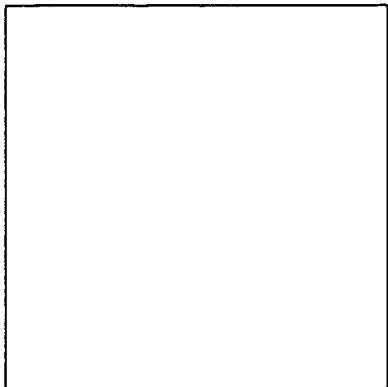
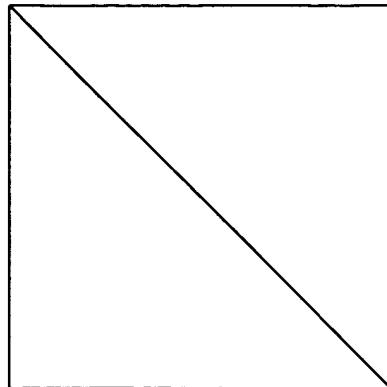


2-dimensional profile (in black) is *linearly* approximated by a sequence of joined lines (in red). Blue patches represent the error due to approximation.

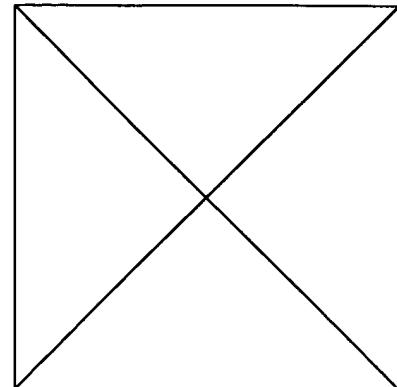
**Figure.1: A Linearization Procedure**



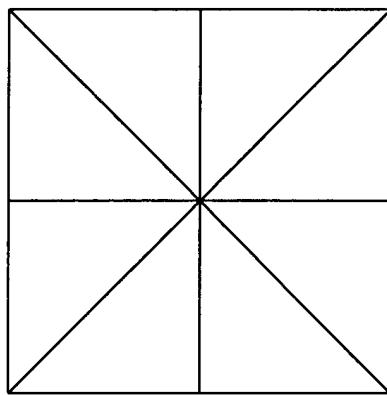
**A Rectangle**



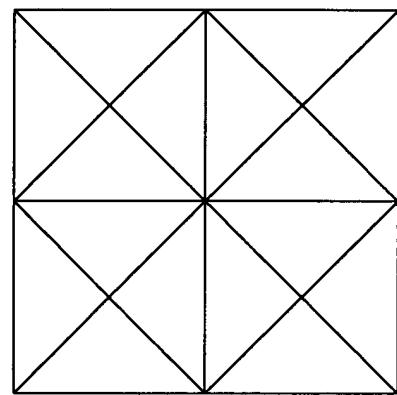
**Stage 1 Decomposition**



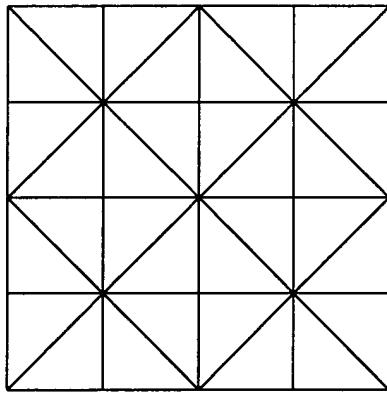
**Stage 2 Decomposition**



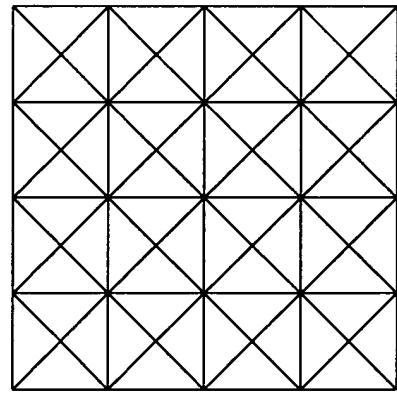
**Stage 3 Decomposition**



**Stage 4 Decomposition**



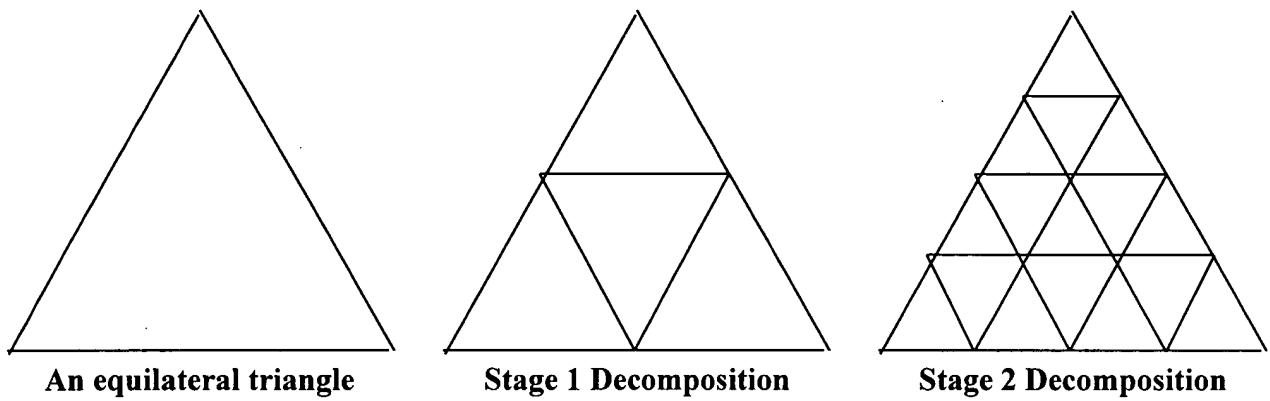
**Stage 5 Decomposition**



**Stage 6 Decomposition**

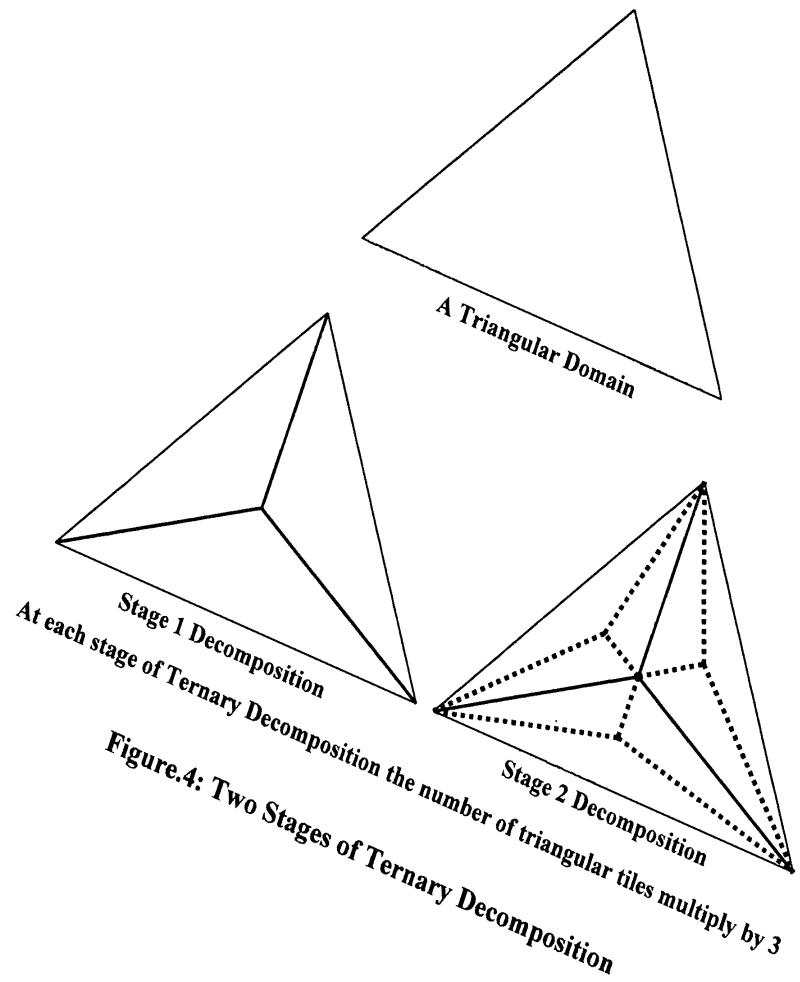
**At each stage of decomposition, the number of right-angled tiles multiply by 2 and their size shrink by  $\frac{1}{2}$**

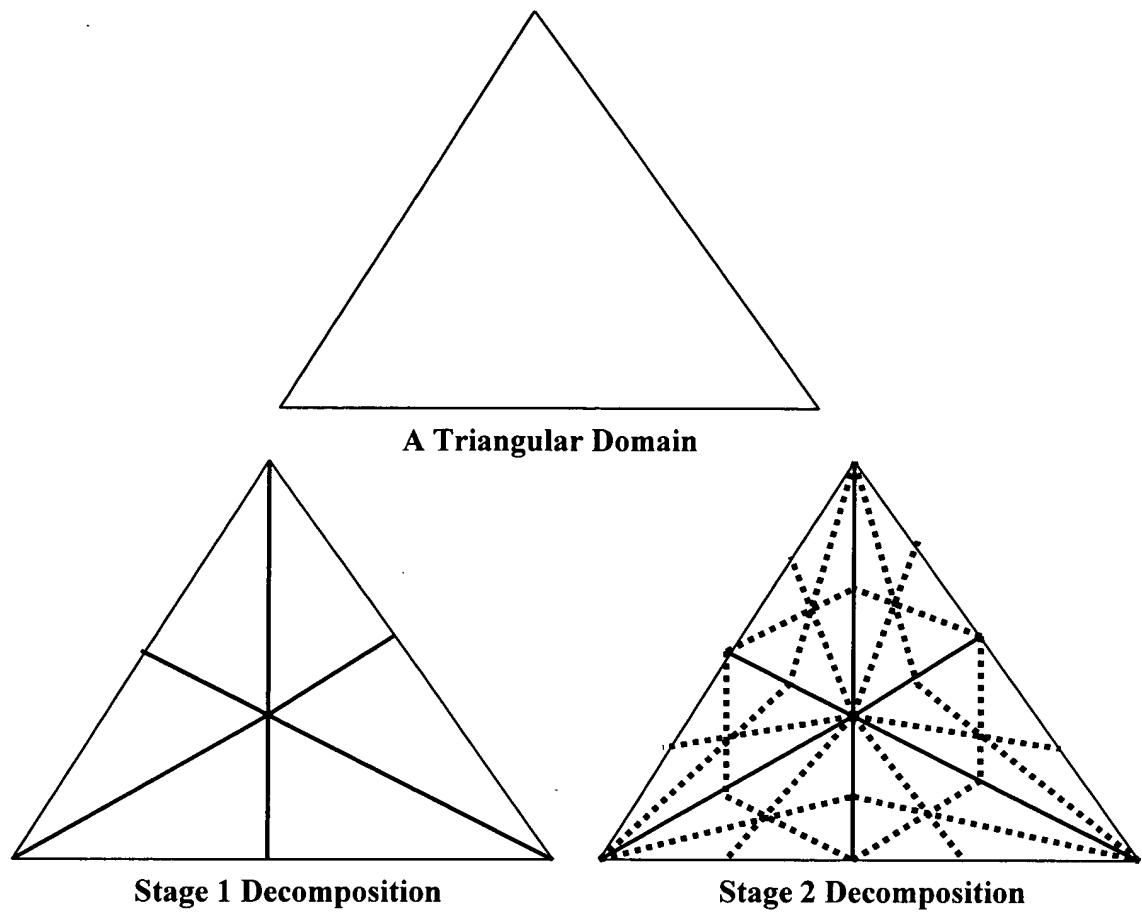
**Figure.2: Six Stages of Peano-Cezaro Binary Decomposition of a Rectangular Domain**



At each stage of decomposition the number of triangular tiles multiply by 4 and their size shrink by  $\frac{1}{4}$

**Figure.3: Two Stages of Sierpinski Quaternary Decomposition of an Equilateral Triangle**





At each stage of Hex-nary Decomposition the number of triangular tiles multiply by 6

**Figure.5: Two Stages of Hex-nary Decomposition**

**Figure.6: Circumscribing projected domain  $\mathcal{D}(X, Y)$  with a rectangular hull**

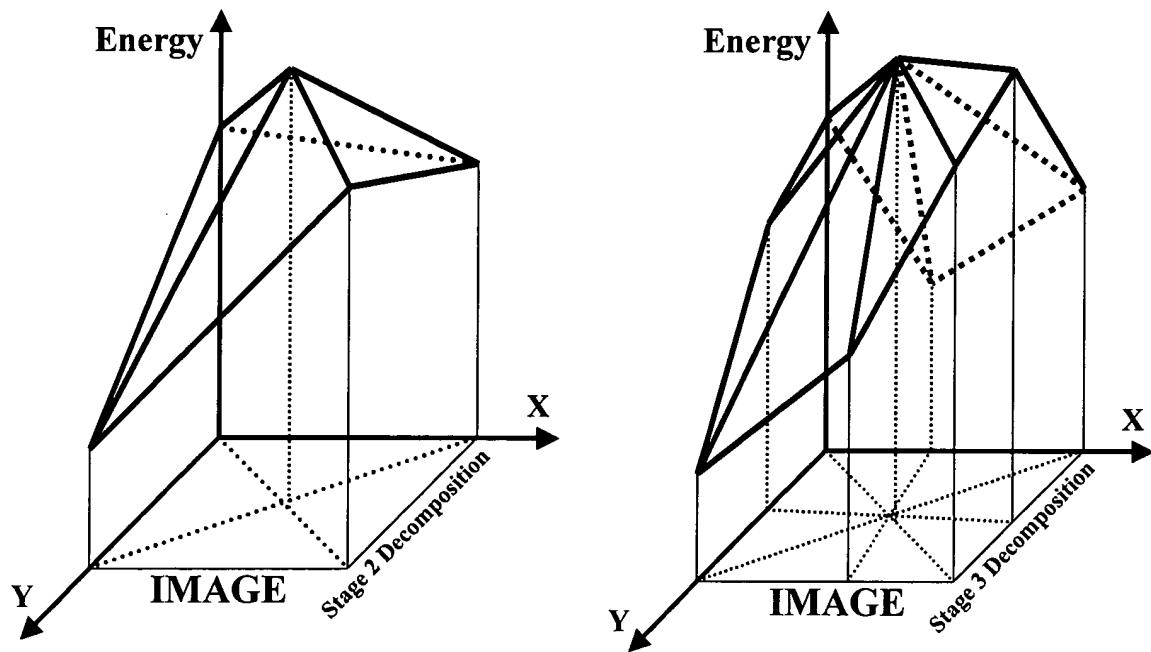
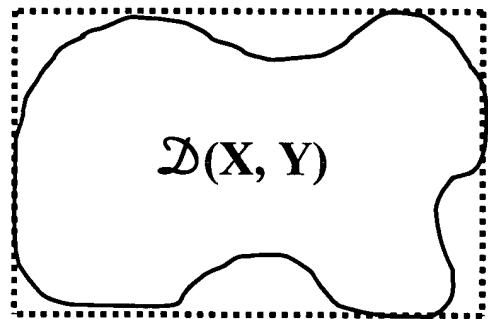
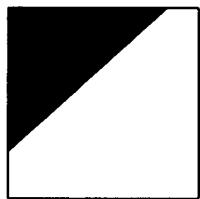
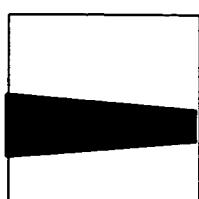


Image is in  $(x, y)$  plane. Triangular *perforated* tiles in  $(x, y)$  plane are projected into  $(\text{Energy}, x, y)$  space represented by *thickened* triangles. The vertices of thickened triangles touch the 2-dimensional image profile in  $(\text{Energy}, x, y)$  space not shown in the diagram. Thickened triangles model image profile.

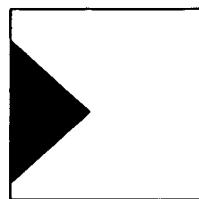
**Figure.7: Stage 2 and Stage 3, 3-dimensional tessellation of a hypothetical image profile in  $(\text{Energy}, x, y)$  space based on Peano-Cezaro decomposition scheme**



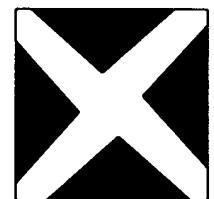
1: An Edge



2: A Strip

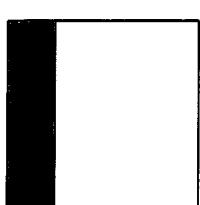
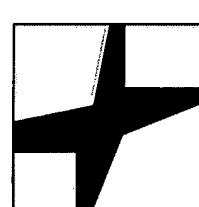
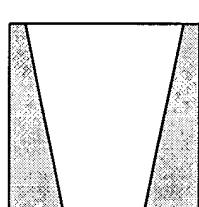
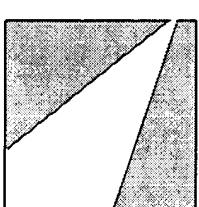
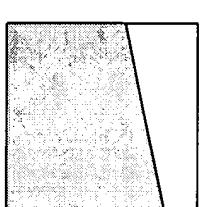
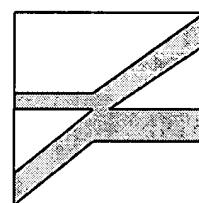
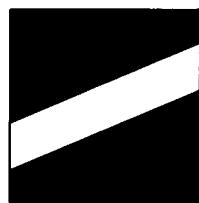
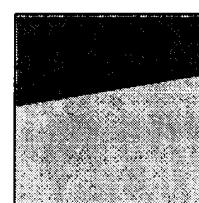
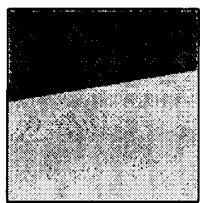
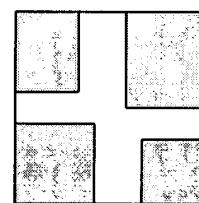
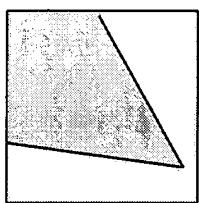
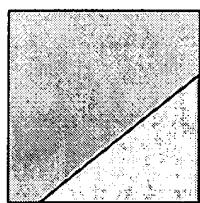
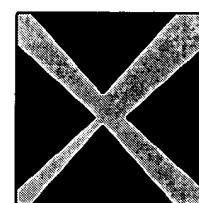
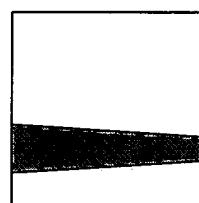
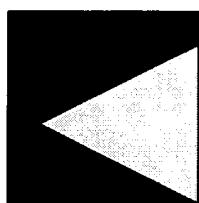
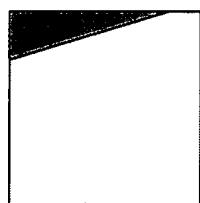


3: A Wedge

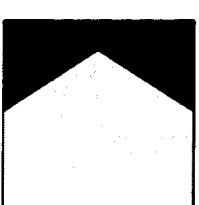


4: A Cross

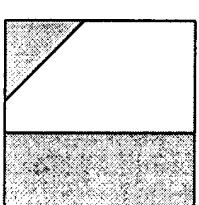
**Figure. 8: Samples of canonical primitive image patterns**



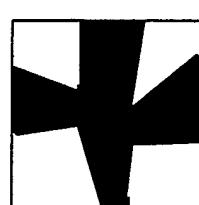
1: Edges



2: Wedges

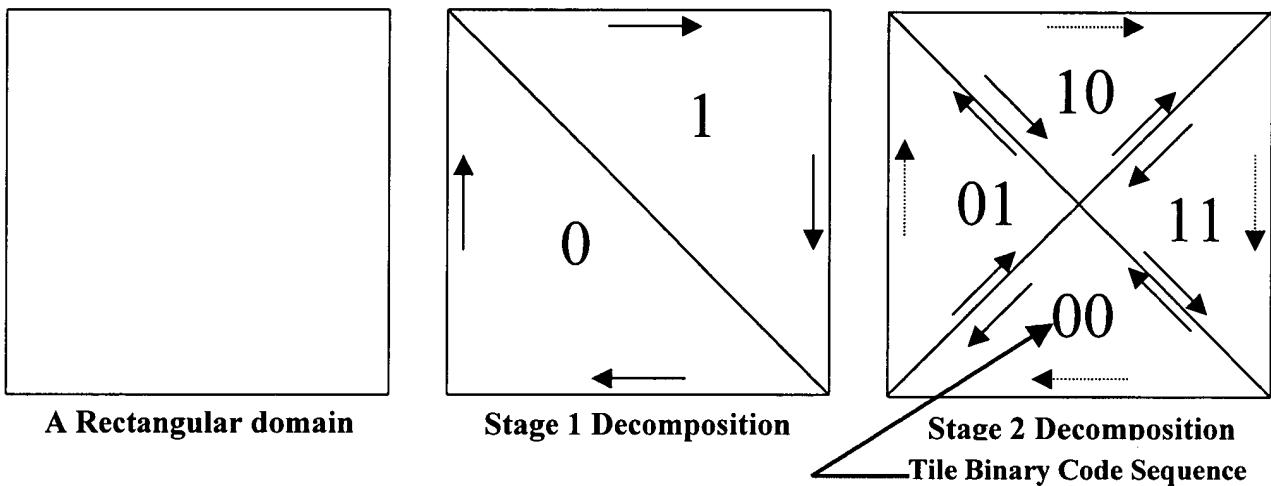


3: Strips



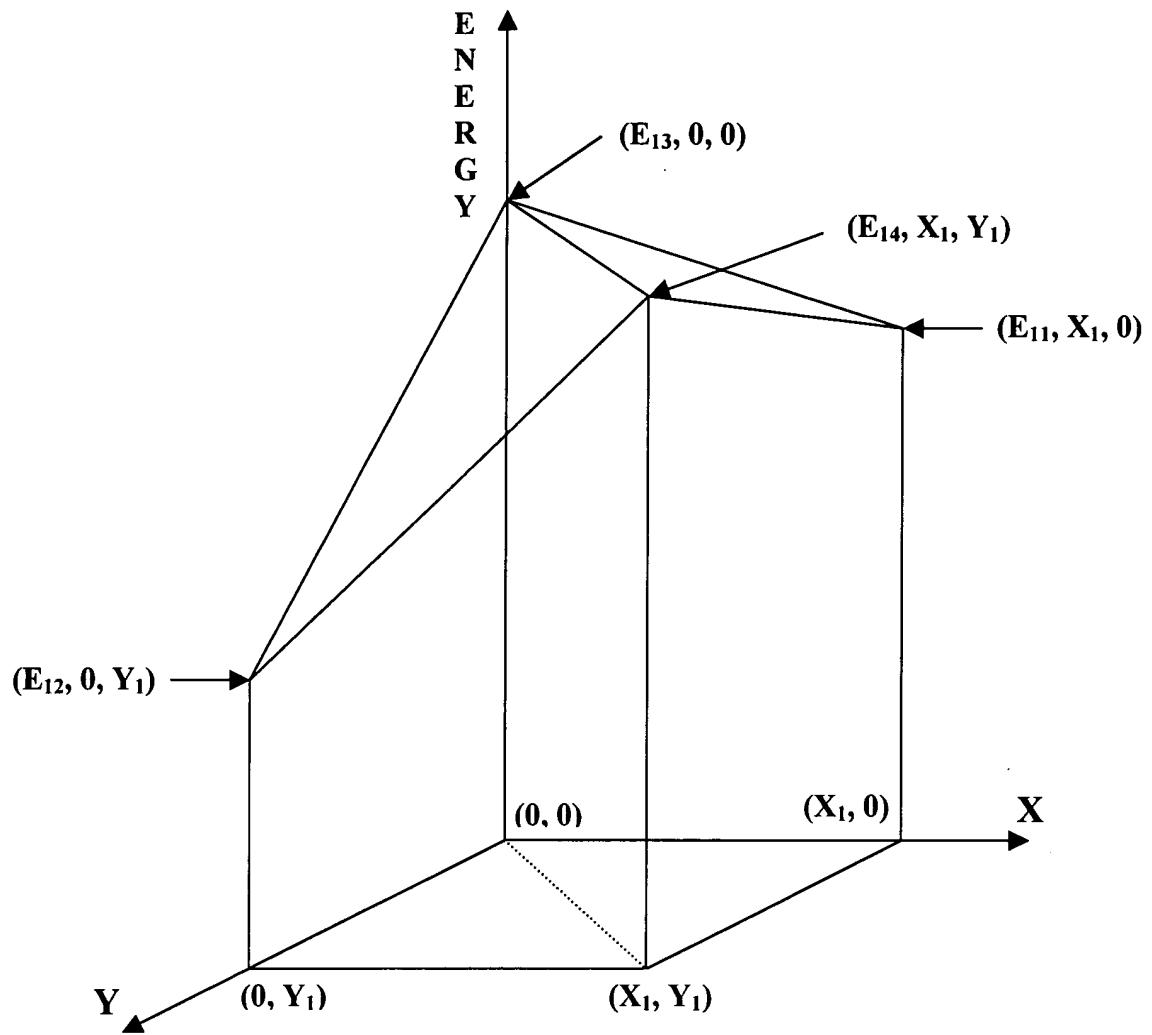
4: Crosses

**Figure.9: Samples of parametric primitive patterns**

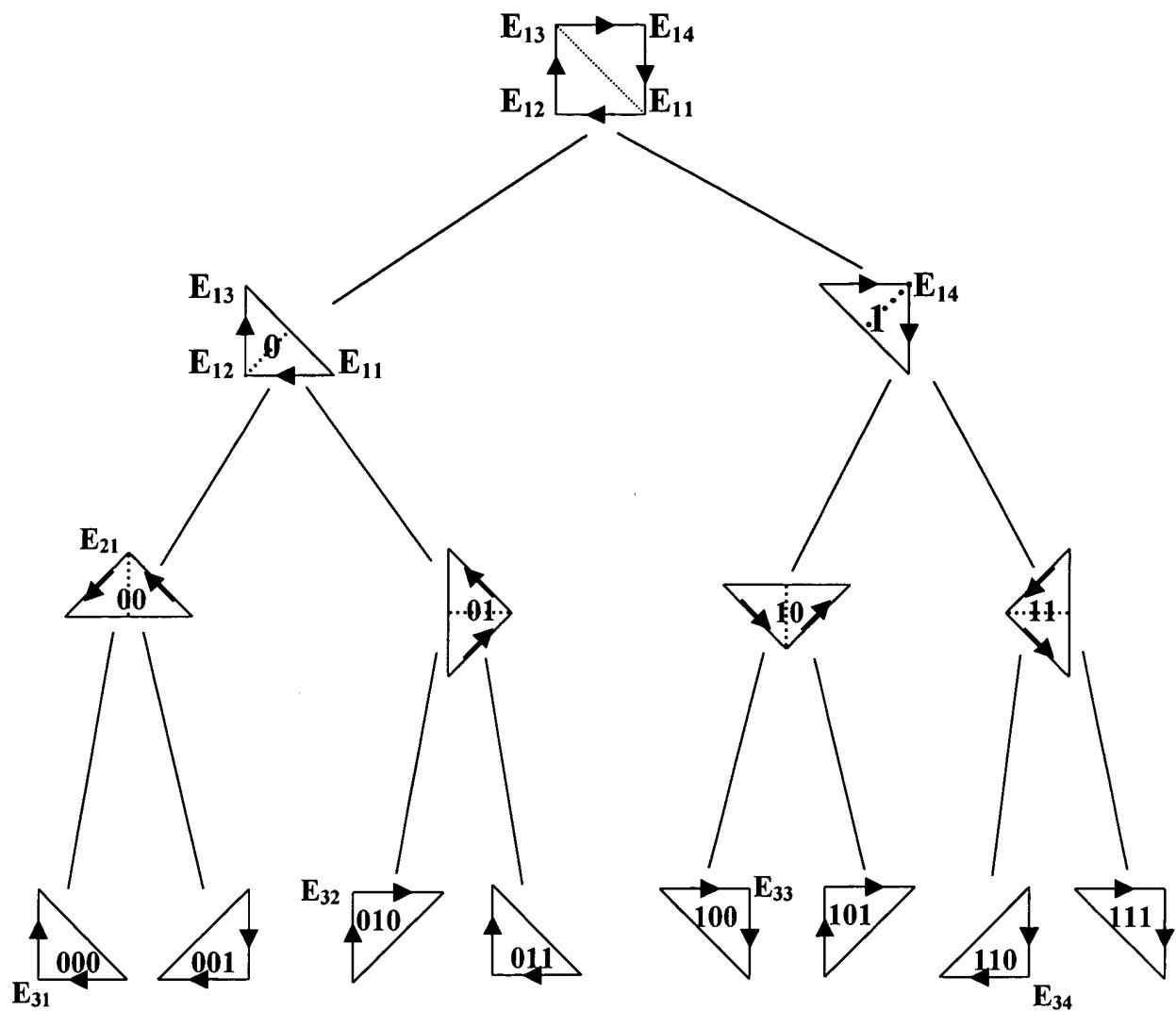


At each stage of decomposition, the number of right-angled tiles multiplies by 2 and their size shrink by  $\frac{1}{2}$ . Solid arrows represent the order of tile sweep at current stage. Broken arrows represent order of tile sweep at preceding stage. A binary code sequence represents the inheritance relation of a tile to its ancestor tiles.

**Figure.10: Four Stages of Peano-Cezaro Binary Decomposition of a Rectangular**

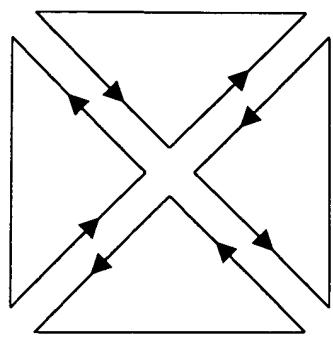


**Figure.11: Stage 1 of 3D Tessellation Procedure**

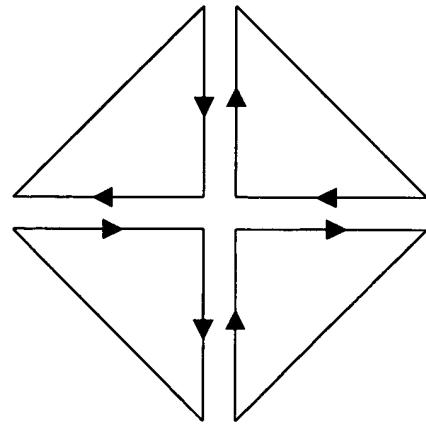


$E_{11}, E_{12}, E_{13}, E_{14}, E_{21}, E_{31}, E_{32}, E_{33}$  and  $E_{34}$  represent energies at tile vertices. Broken lines represent the axis of decomposition.  
 Bit values inside a tile represent a code sequence

**Figure.12: Binary tree representation of Peano-Cezaro**

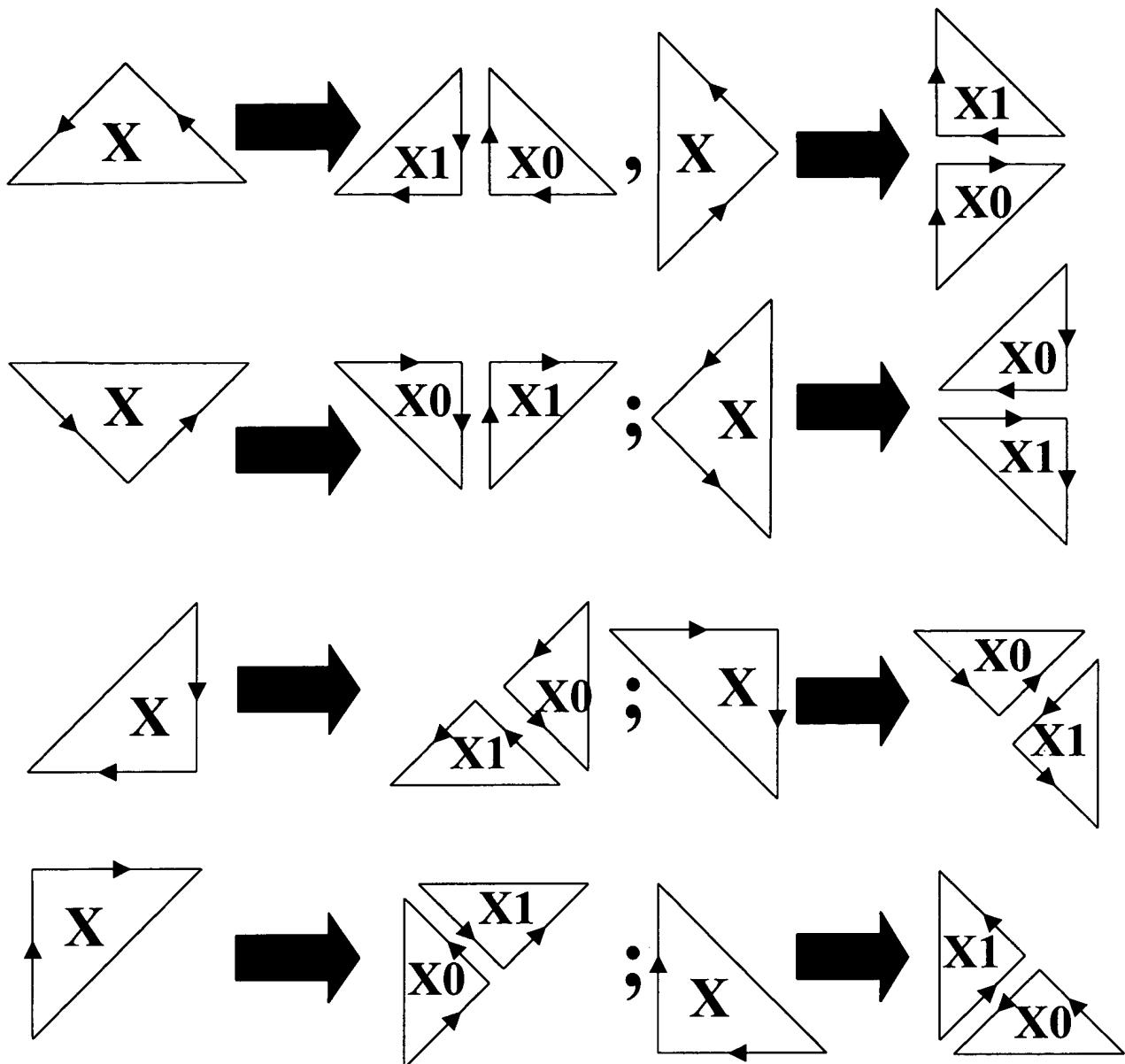


**A: Even level tiles**



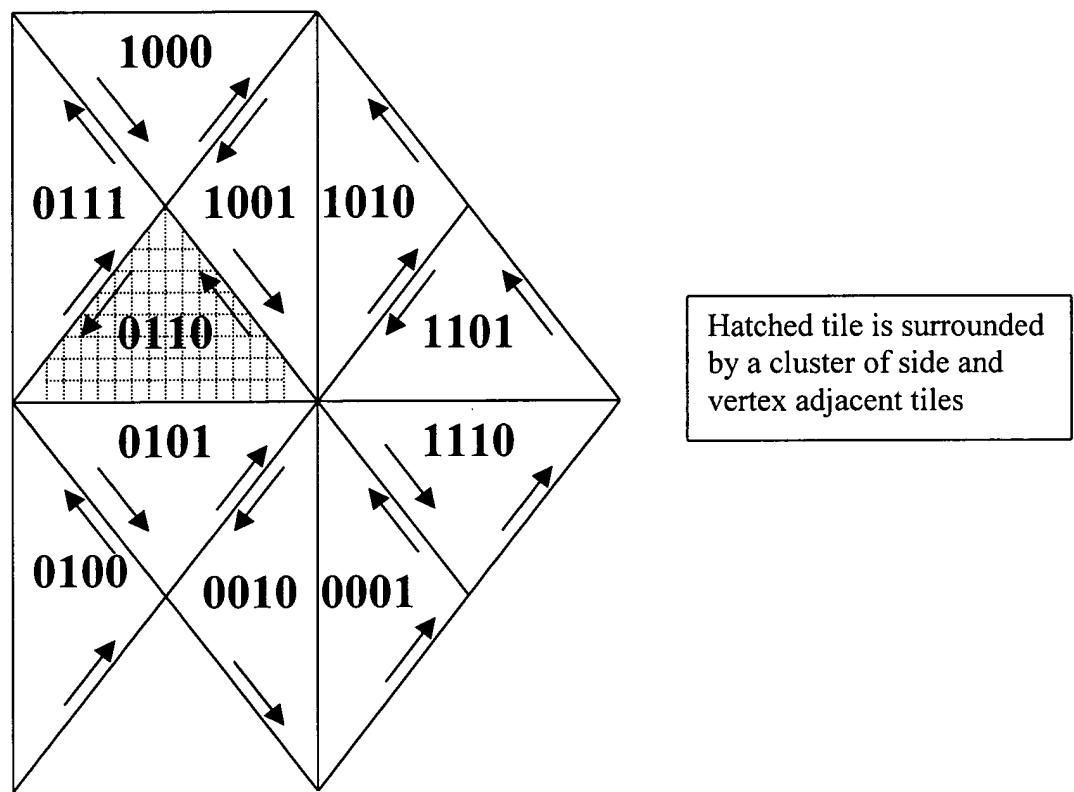
**B: Odd level tiles**

**Figure.13: Eight types of tiles divided into two**

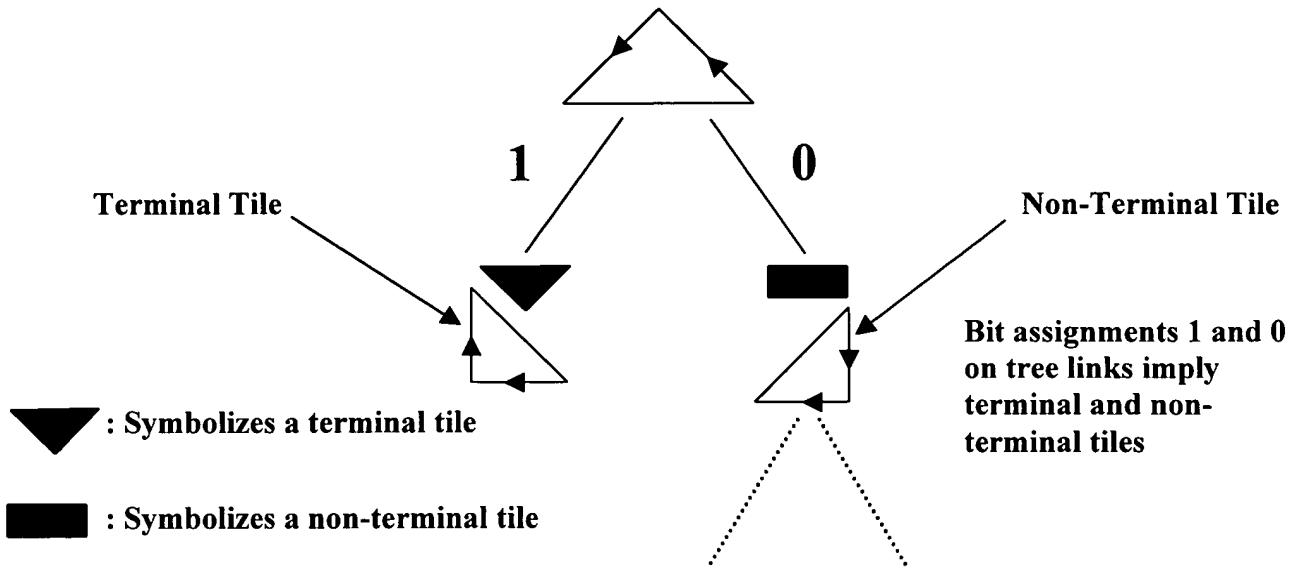


**X** is code sequence of tile before decomposition. **X0** and **X1** are code sequences of *children* tiles after decomposition.

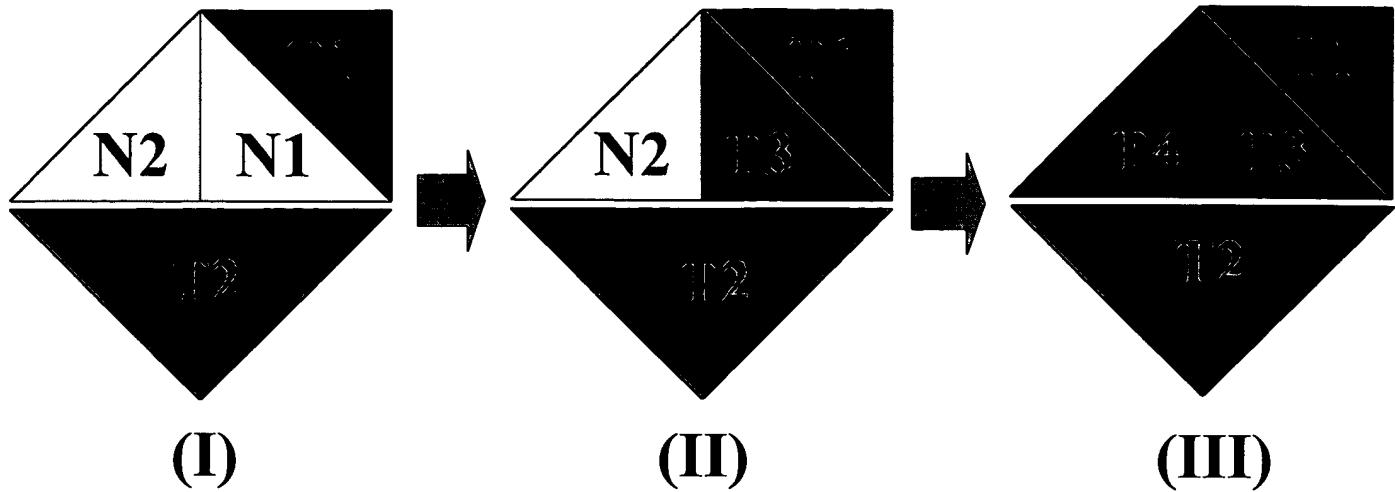
**Figure.14: Decomposition grammar for all eight types of tiles with bit assignments**



**Figure.15:**A cluster of side and vertex adjacent tiles



**Figure.16: Fragment of a binary decomposition tree**

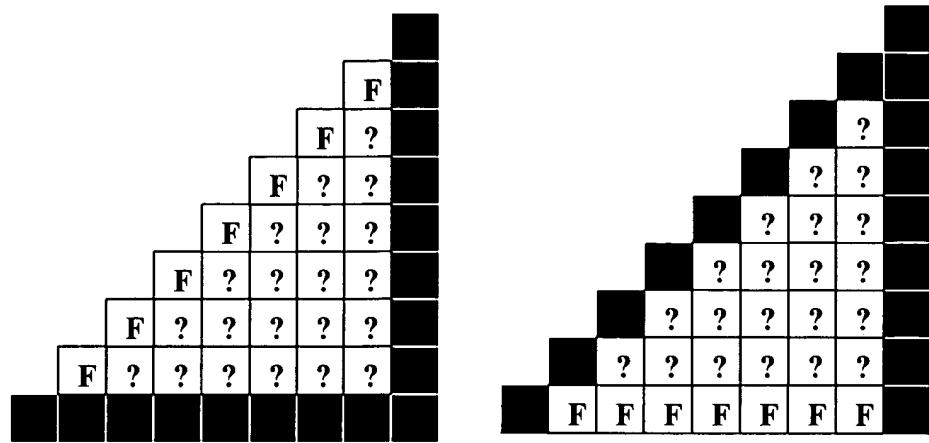


**T1, T2, T3 and T4** stand for *modeled* terminal tiles in Filter 2. **N1** and **N2** stand for to-be-modeled non-terminal tiles in Filter 2. In state (I), non-terminal tile **N1**, being surrounded by more terminal tiles than non-terminal tile **N2**, has higher chance of being accurately modeled; hence, it has precedence over **N2**. In state (II), **N2** is the only non-terminal tile left to be modeled. State (III) is the final

**Figure.17: Tile state transition in Filter 2 processing**

**█** : Stands for an image site with known energy value

**?:** Stands for an image site with unknown energy value to be estimated using learning units



Two 9x9 size right-angled triangular structures

**F:** Stands for an image site with unknown energy value but whose primary features are extracted and used as input to the learning unit corresponding to tile structure



Two 5x5 size right-angled triangular structures

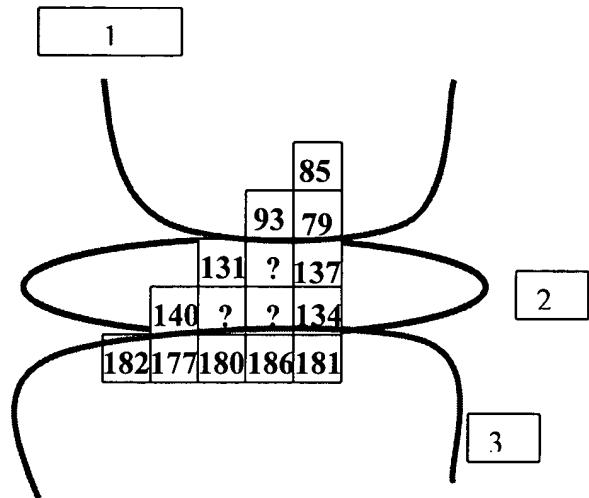
**Figure.18: Four tile structures with right-angled side sizes 9 and 5**

**Application of classifier to energy values at the boundary sites of the tile in the diagram gives rise to partition of the set of energy values into three homologous sub-sets**

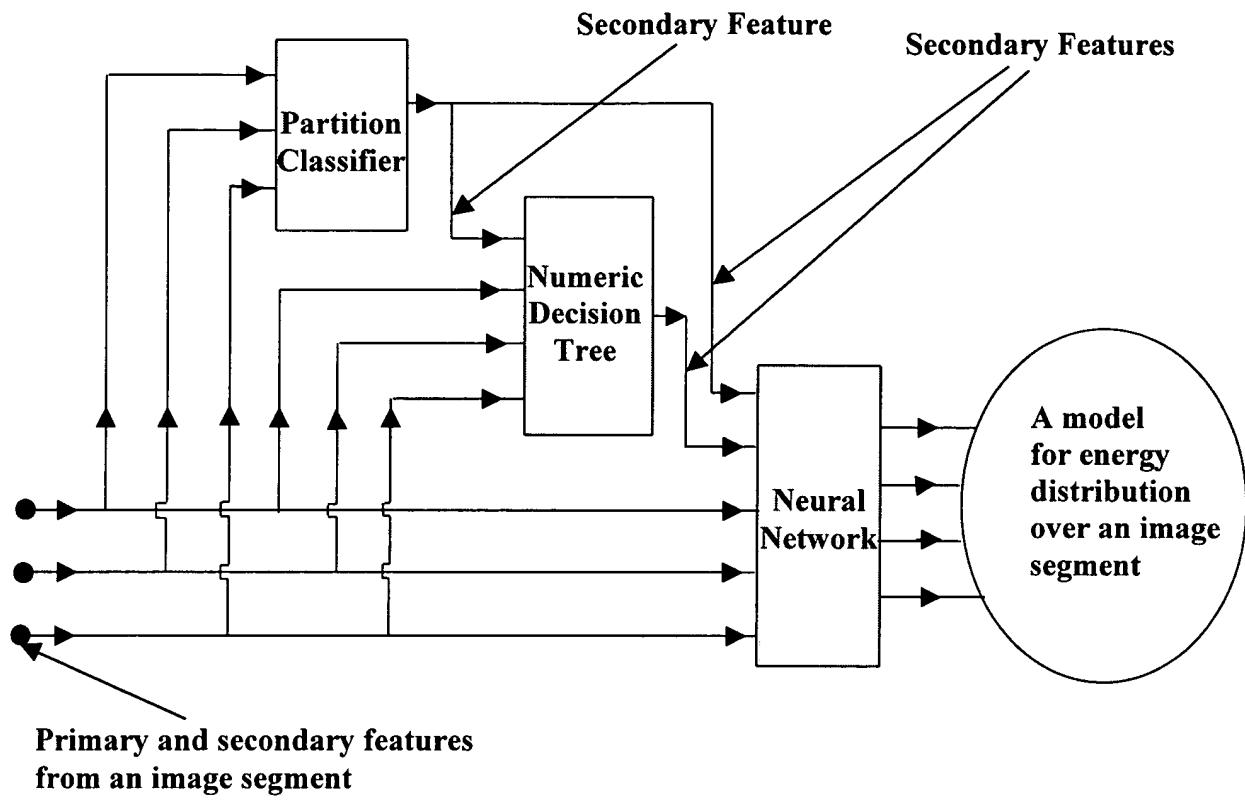
**Partition (79, 85, 93) is delimited by contour 1**

**Partition (131, 134, 137, 140) is delimited by contour 2**

**Partition (177, 180, 181, 182, 186) is delimited by contour 3**



**Figure.19: Partition of energy values using a classifier**



A learning unit is composed of a classifier, a numeric decision tree and a neural network

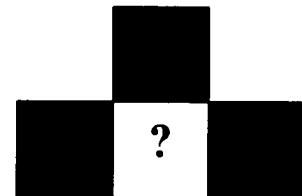
**Figure.20: A Learning Unit**



: Stands for a site with known energy value



: Stands for a blank site with unknown energy value



A 3x2 size tile structure with one blank site. The *raw* energy value at the blank site is stored in Residual\_Row

**Figure.21: A minuscule tile structure with one blank site**

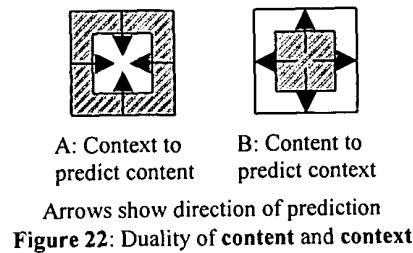


Figure 22: Duality of content and context

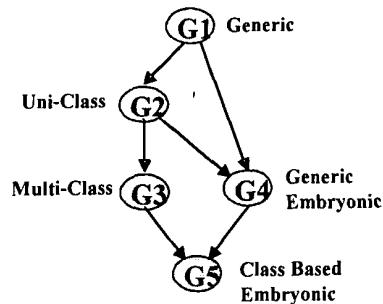


Figure 23: UC codec road map

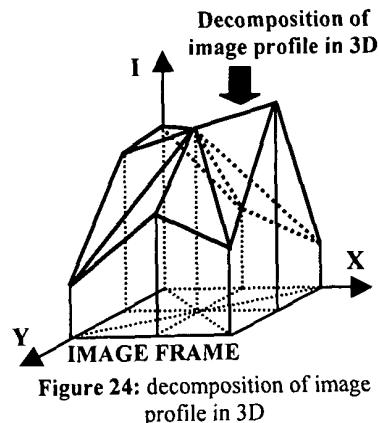


Figure 24: decomposition of image profile in 3D

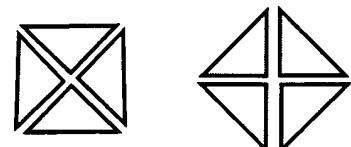


Figure 25: Binary quadratic

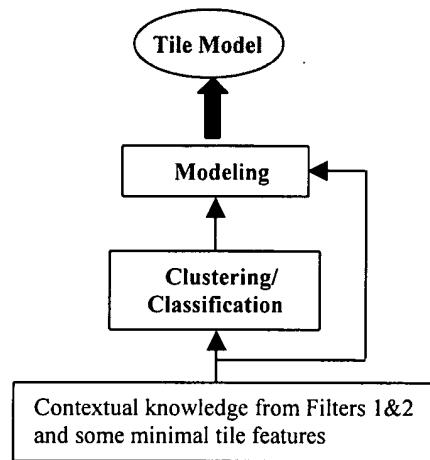
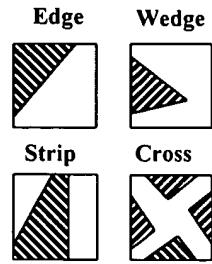
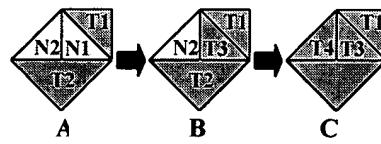


Figure 26: A learning

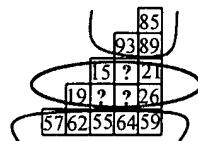


**Figure 27:** Primitive patterns



T1, T2, T3 and T4 are *terminal* tiles  
 N1 and N2 are *non-terminal* tiles

**Figure 28:** State transition in Filter2



**Figure 29:** Clustering boundary intensities

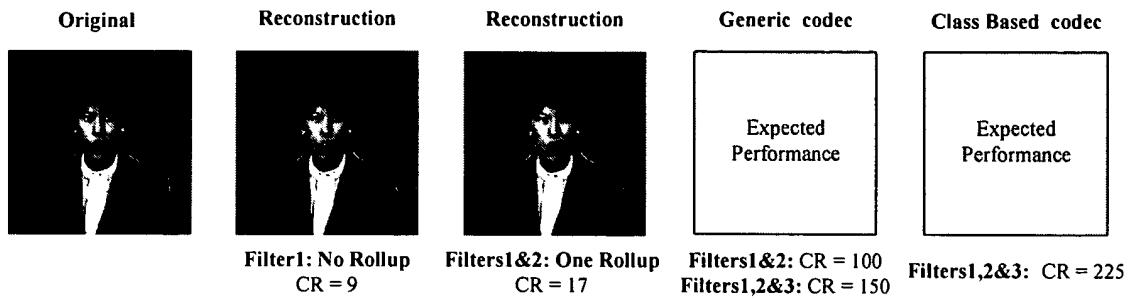


Figure 30: UC's Current and Expected Performances

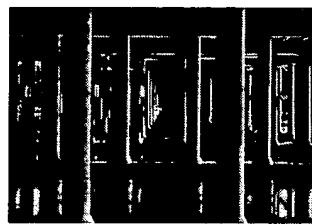


Figure 31: Pillars

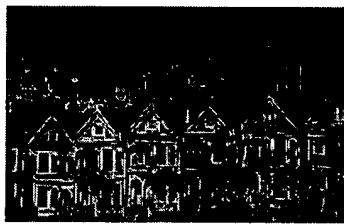


Figure 32: Town

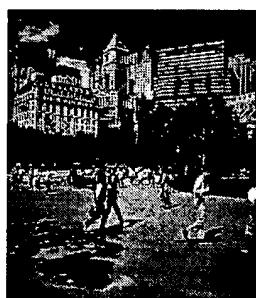
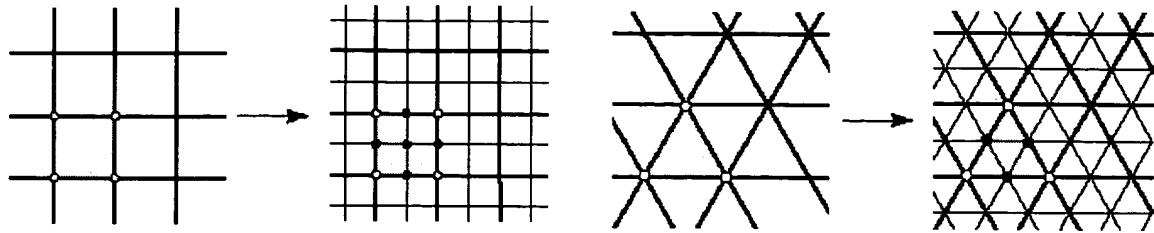


Figure 33: City Park



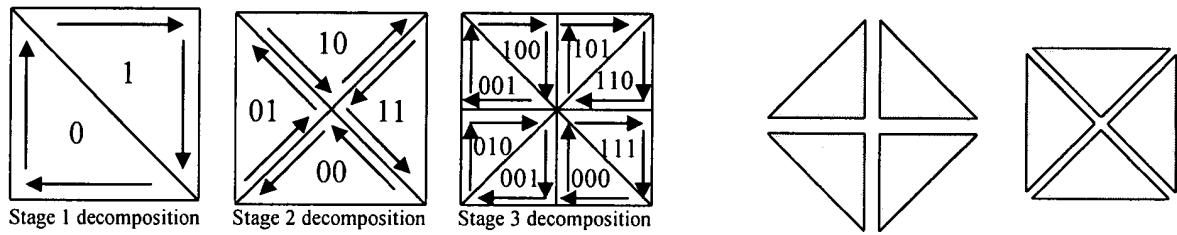
Figure 34: Waterfall



a: 2D quadrilateral quaternary decomposition

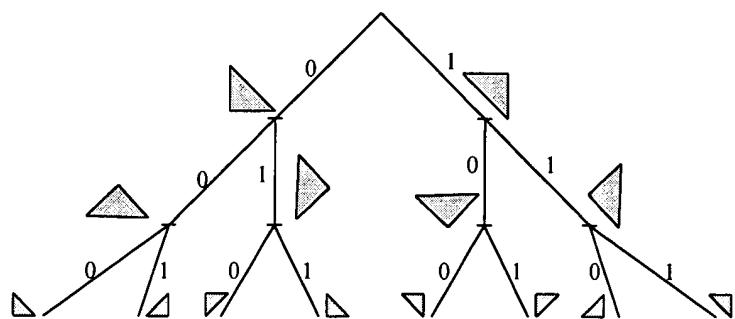
b: 2D triangular (Sierpinsky) quaternary decomposition

**Figure 35:** Subdivision rules for triangular / quadrilateral meshes



**Figure 36:** Three stages of decomposition

**Figure 37:** Eight tile types



**Figure 38:** Tree representation of triangular decomposition

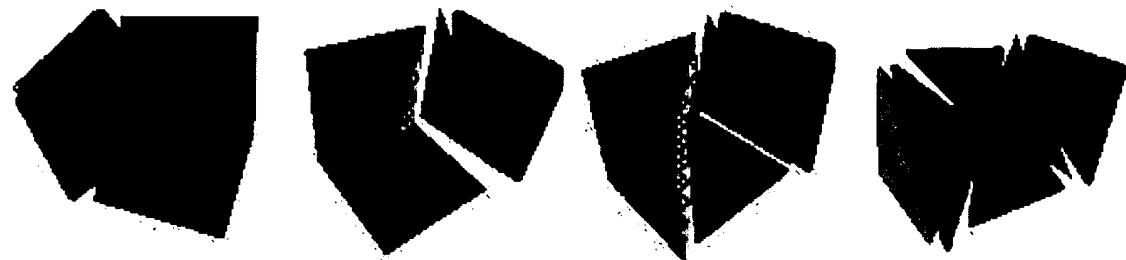


Figure 39: Standard unit-cube tetrahedral cover

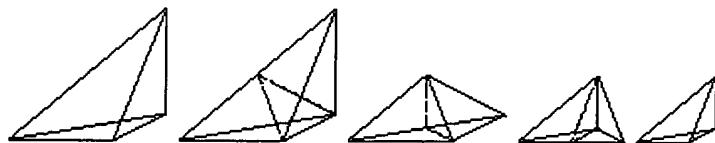


Figure 40: Decomposition of a tetrahedron by recursive bisection

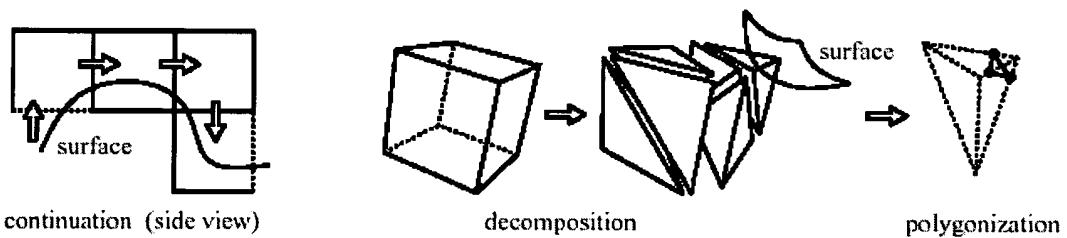
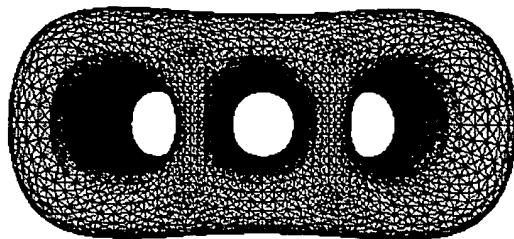
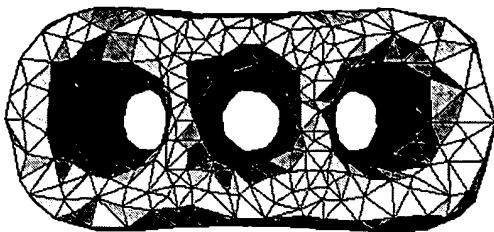


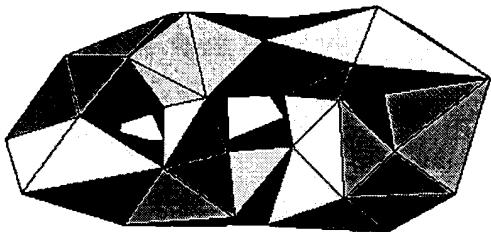
Figure 41: Overview of the mesh extraction procedure



a. Fine mesh at the smallest scale



b: Intermediate mesh



c: Coarsest mesh

Figure 42: Meshing at three different scales

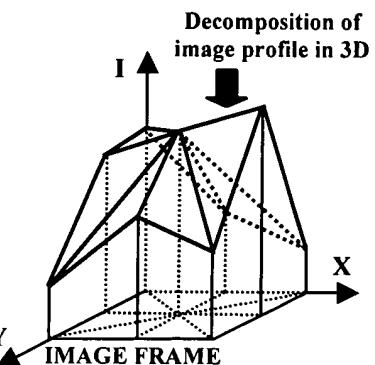


Figure 43: Decomposition of image profile in 3D

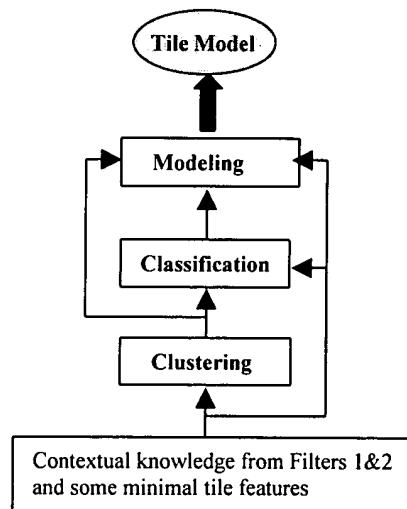
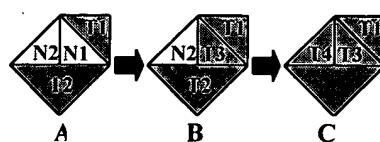


Figure 44: A learning unit



T1, T2, T3 and T4 are *terminal* tiles  
 N1 and N2 are *non-terminal* tiles

Figure 45: State transition in Filter2